The Economic, Social and Political Impact of the California Ecosystems Protection Act

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ABSTRACT: California Assembly Bill 1788 and establishment of the California Ecosystems Protection Act indicates the evolution of public opinion regarding rodent management products is moving away from the use of poison. Similar actions have taken place in the province of British Columbia and the state of Massachusetts, with initiatives in the states of Washington and Connecticut. These events signal a trend in pest management that requires attention. There are many aspects of California's law that will require further refinements such as enforcement, best practices, and the economics of the action. The FYXX foundation 501c(3) non-profit organization has undertaken to assess these elements of alternate rodent IPM programs including any offsetting benefits of public and employee perceptions. Data was collected from three sites: two animal sanctuaries and a large commercial business district. Strategies were as follows; site #1, an IPM program including exclusion, fertility control, repellents, station monitoring with relocation and reduction (98% population reduction); site #2 IPM including fertility control, monitoring and station relocation, (80% population reduction) and site #3, IPM including station lure baiting followed by targeted fertility control, and monitoring (91% population reduction). All data were analyzed with review by professional pest managers, facility management personnel, municipal agencies, and FYXX staff. Employee interviews and surveys indicated that there was a skepticism at initiation of the study, however, by month #3 a reversal to strong support for the new program and high satisfaction with a poison-free facility. These data indicate that collaborative work between product manufacturers, professional pest managers, and users can provide new alternatives to IPM programs that are economically sound, socially, and politically responsive to a new trend in pest management.

KEY WORDS: California Ecosystems Protection Act, economy, policy, rodent fertility control, second generation anticoagulant rodenticides

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INTRODUCTION

Commensal rodents have been a scourge of humankind for millennia, destroying crops in the field, contaminating stored grains and other foodstuffs, and passing zoonotic diseases to us. Our attempts to control rats has primarily depended on use of lethal means, from physical trapping to widespread application of poisons. Since WWII the use of first-generation then second-generation poisons has steadily expanded. Today the most common poisons used are second-generation anticoagulant rodenticides (SGARs) (Tripathi 2014).

In recent times the growth of integrated pest management (IPM) strategies has yielded additional rodent population management tools that are non-toxic and do not require the use of SGARs. Tools such as trapping, both lethal and non-lethal, repellents, physical exclusion, and fertility control have been successfully used (Glass et al. 1997, Dyer and Mayer 2014, Pyzyna et al. 2014, Hansen et al. 2016, Pyzyna et al. 2018, Rahelinirina 2021). IPM presents a conundrum for professional pest managers as their existing business model is built on using poison. Without doubt, poison kills rats and is inexpensive to use. However, the practice poses poisoning and death of non-target animals, even children and companion animals, and contaminates the environment. Because it is impossible to poison all rats, not for a lack of trying, poison does not solve the self-perpetuating rodent population problem even after decades of use.

Economic, social, and political relationships intersect when trying to control rodent populations. The best example that illustrates this intersection is the creation of California Assembly Bill 1788 to place a moratorium on the use SGARs (with some exceptions; California Legislative Information 2020) that became law as the California Ecosystems Protection Act on January 1, 2021. This Act places a moratorium on using SGARs until it can be shown that SGARs do not adversely affect wildlife. Based on recent scientific studies, the moratorium is unlikely to be reversed (Nakayama et al. 2019, Siers et al. 2020, Niedringhaus et al. 2021, Roos et al. 2021).

The development of the SGARs ban in AB1788 was initiated in the social arena. Involvement of environmental and animal protection groups such as the Center for Biological Diversity, Animal Legal Defense League, and Raptors Are The Solution (R.A.T.S.) of the Earth Institute, stimulated public dialogue leading to pressure on the political system. Policy was debated on the grounds of public health, animal welfare, and environmental contamination leading to a call for the State of California to use 21st century solutions instead of 20th century poisons. The pest management industry representatives argued against AB1788 because they had not been provided an EPA-registered alternative to poison such as fertility control until August 2016.

The economic issues at play were the low cost of poison deployment when compared to other strategies such as labor for trapping, exclusion repair costs, fertility control product, and monitoring that are more expensive.

In this report we provide data to address concerns of social, political and economic impacts in California as the SGARs discussion moves across the U.S. and Canada (British Columbia 2021, Commonwealth of Massachusetts 2021, State of Connecticut 2022).

METHODS

Studies in three different sites were conducted to better understand the interplay of social awareness and public opinion, government policy, and economic considerations.

Study Site #1

This study was conducted at an animal rescue, clinic, and adoption facility located in the Los Angeles city limits in a mixed-use, population-dense area in collaboration with Best Friends Animal Society (https://www.bestfriends.org). The facility is approximately 40,000 square feet under cover and sits on 136,261 square feet of land or approximately one-half of a city block in the area. The layout of the study site is depicted in Figure 1. The structures are single-story frame and stucco building with suspended acoustic ceiling covering over enclosed areas. The outdoor kennels, exercise yards, and cat colony are covered with a free-standing corrugated metal roof and canvas structures allowing for fresh air exchange. Domestic species under management include approximately 400 canines and felines. Wildlife rodent species identified on site include *Rattus rattus* (roof or black rat) and *Mus musculus* (house mouse). The facility is managed by 75 full-time staff and 200+ volunteers full/part-time. The sanctuary property houses dogs, cats, kittens, and puppies, some of which are medically compromised. Full-time veterinary services with clinic are also available to the public and sanctuary. Poison rodent control strategies have not been used on site for at least 12 years.

Before starting the on-site study (11 December 2019), several exclusion measures were completed by the facility manager to exclude rodent access to building interiors. These improvements included exterior metal siding, removed roll-up window access to ceiling, blocked access to kennels from floor, blocked rodent drain access to outdoor kennels, plexiglass doors on laundry shelves, all indoor drains covered with metal mesh, trimmed perimeter trees, rat-proof trash receptacles and increased trash removal to daily, secured dog and cat food in rat-proof bins, debris cleared from the entire property, and canvas laundry carts replaced with metal ones, at a total cost of $24,000 (pers. commun. Best Friends Director 2020).

Indexing of the rodent populations on the site was developed to estimate differences in rodent population abundance and not numerical abundance following the indexing principles reported by Engeman (2005). Rodent activity at the study site was quantitatively analyzed by rodent consumption of a first-generation liquid fertility control agent (ContraPest®, EPA reg. No. 91601-1, Patent #9956235 Reducing the reproductive capacity of mammals, co-inventors L. P. Mayer and C. A. Dyer), and correlated with infrared, digital field camera trap images for analysis (Lambert et al. 2018). Design of the bait distribution strategy involved a complete rodent site assessment by the authors and professional pest services provider and was reviewed with the host facility management prior to bait station deployment. Sixty-five bait stations (JT Eaton Rat Fortress #903, Twinsburg, OH) were located and mapped throughout the facility and baited with two tanks of liquid fertility control product (ContraPest®, 550 ml plastic tanks/feeding trays, SenesTech, Inc., Phoenix, AZ), containing 0.096% 4-vinylcyclohexene diepoxide (VCD, a Proposition 65 chemical; State of California 2022) and 0.001% triptolide (Dyer and Mayer 2014). Bait station inspections were performed weekly (December 2019 through February 2020) then biweekly (March through May 2020) and reduced to once a month (June through February 2022) as rodent activity declined. Consumption data was reported in milliliters (ml) and recorded for each bait station number during each inspection period (weekly, bi-weekly, or monthly) by the licensed, on-site applicator.

Activity observation stations in the form of field cameras (Toguard, 20MP 1296P, Toguard Video Inc., Shenzhen, China) were numbered and placed in feeding area (bait station locations). Cameras were placed at an optimal height of 61 cm and an approximate distance of 183 cm from bait station entrances. Data image collection started at 1200 hours on Monday of each week and ended on the following Thursday at 1200 hours, for a total period of 6 weeks. Each week on Thursday afternoon data was digitally downloaded. Each image captured recorded camera number, date, time of photo, and ambient temperature with 3 camera photo bursts set 7 seconds apart to track rodent activity near the bait stations. This series was followed by a 30-second reset period to avoid duplicate capture of the animal (Meek et al. 2012).

To determine age distribution of the population, snout to base-of-tail measurements were collected from camera images and analyzed using Image J Software (National Institutes of Health, Bethesda, MD). Determination of age specifically for the black rat was indexed as <16.5 cm for a juvenile and >16.5 cm for an adult (WAZA 2020). See representative photo (Figure 2) tracing base of tail to tip of snout.

Rodent reproductive and physical data were collected at a 9-month timepoint where rodent activity had been reduced by 79%. Rodents were captured in live traps with two weeks of baited conditioning in non-activated traps. Baits consisted of peanut butter and oatmeal/dog biscuit on card platforms. The traps were checked, and conditioning bait was refreshed several times daily. Traps were then baited and set to allow for live trapping. The traps were set nightly between 17:00-18:00 and checked early in the morning 07:00-08:00. Trapping continued for three subsequent nights. Captured animals were placed in a cloth sack and transferred to the clinic where they were immediately anesthetized. Rats were anesthetized using an isoflurane anesthesia machine with oxygen at 2-3 L per minute and isoflurane at 3L until they were at a suitable plane of anesthesia to handle. If the animal started to wake up, they were returned to the chamber until they again reached a suitable level of anesthesia to handle. Ultrasound was performed on females with a SonoScape SS1-1000 ultrasound (Sonoscape Medical Corp., Shenzhen, China) using a 4.0-8.5 mhz probe set at the minimal depth to ascertain pregnancy. Subsequently, animals were weighed (gm), measured for length (tip of snout to base of tail) and

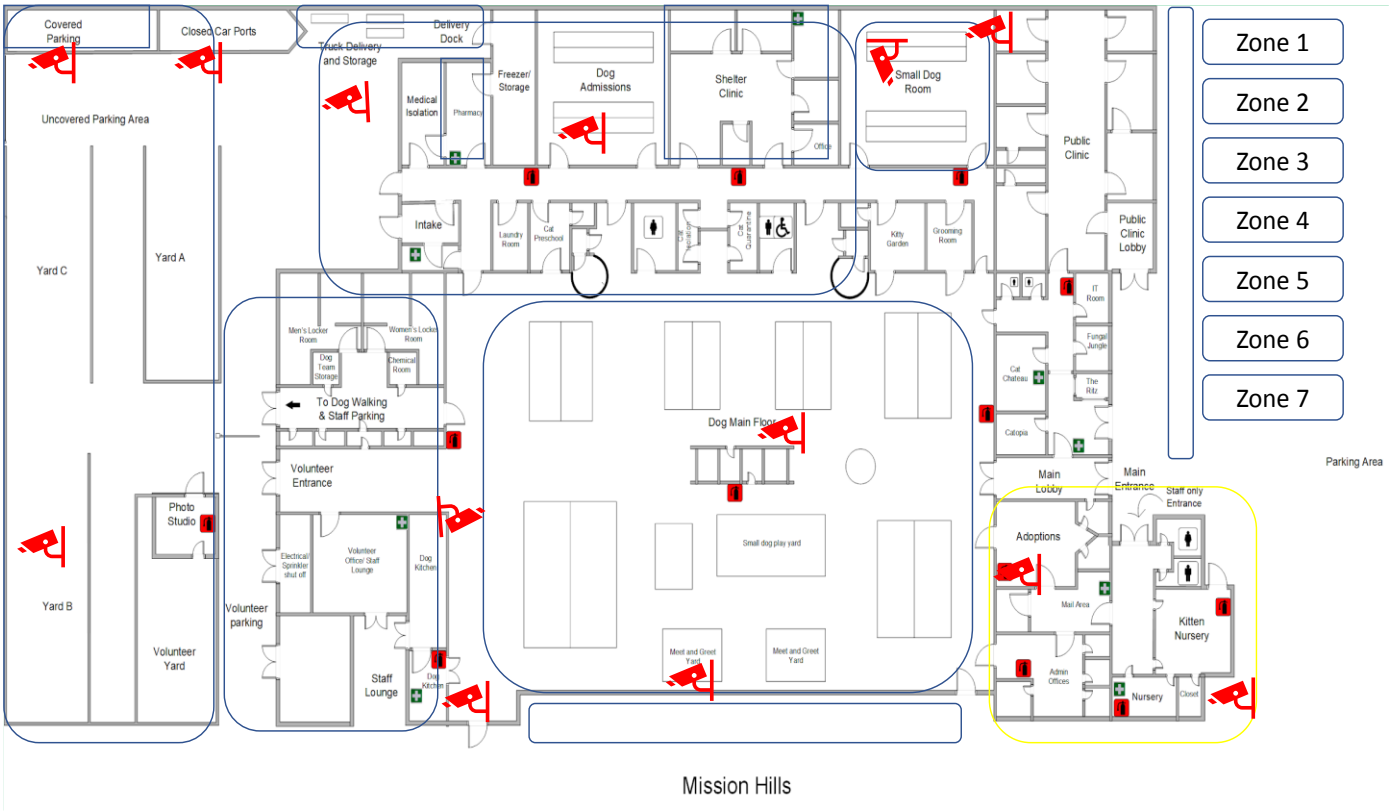

Figure 1. Study site #1, Los Angeles, CA. Zones of activity, with 1 being highest and 7 lowest, were mapped utilizing 8 months of individual station consumption data. Cameras indicated by icons were placed for NIH imaging analysis of age.

Figure 2. Representative camera image with NIH Image J overlay to determine size. (Adults >16.5cm, Juveniles <16.5 cm). Camera collection data at the bottom of each image.

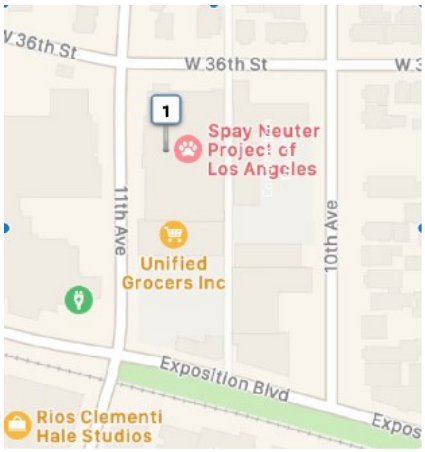

Figure 3. Map of project layout for study site #2, Los Angeles, CA. Baiting site is indicated by marker designated (1). The construction project is indicated by the square block immediately adjacent to the site.

testicular conformation documented, then each animal was placed in an individual cage with heated pad until recovery. Rats were then placed in recovery cages with bedding on a heated surface until recovered from anesthesia and were released at the location they were trapped. All recoveries were uneventful.

All procedures followed the Animal Welfare Act guide for care and use of animals, and AVMA guidelines for anesthesia and handling. No animals were euthanized in this study and no animals underwent surgery. This study did not require an Institutional Animal Care and Use Committee approval.

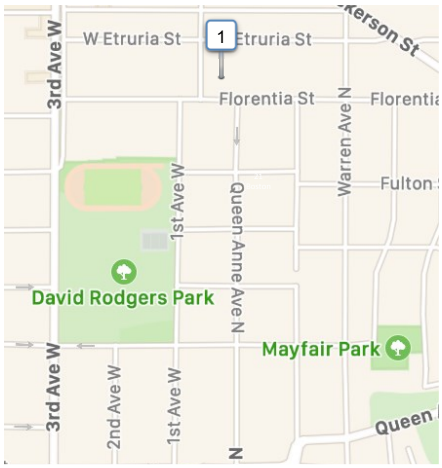

Figure 4. Study site #3 (marker (1) in thick red box) includes 10 blocks commercial businesses, and single block of mixed-use construction project (Block depicting "21 Boston" project), Queen Ann Business district in Seattle, WA.

Staff and volunteer welfare and positive mental health effects were assessed by individual interviews. The purpose of the interviews was twofold: 1) to solicit first-hand experiences from those most directly affected by the rodent challenge; and 2) to integrate the human experience with the challenge and its resolution. In preliminary discussions with management, it was decided to solicit representative participation from personnel facility-wide. All participants signed "Informed Consent" forms. The recorded interviews were conducted by Zoom. Those who chose to be interviewed worked in heavily infested areas. All participants had had prior experience working in animal rescue (2-8 years).

Study Site #2

This study was also conducted at a Best Friends animal rescue, clinic, and adoption facility located in the Los Angeles city limits in a mixed-use population-dense area. The facility of approximately 60,000 square feet on two floors occupying 40,000 square feet of land comprising approximately one-quarter of a city block in the area. The layout of the study site is depicted in Figure 3. Domestic species under management include canines and felines. Wildlife rodent species identified on site include *R. rattus* (roof or black rat) and *M. musculus* (house mouse). Twenty bait stations (JT Eaton Rat Fortress #903) were located and mapped throughout the facility and baited with (2) 400 ml tanks of liquid fertility control agent containing 0.096% 4-vinylcyclohexene diepoxide (VCD) and 0.001% triptolide. Rodent population, indexing, fertility control treatments, and data analysis was conducted as described for study site #1. Age determination and conformational studies were not conducted at this site.

Rodent management on this site was impacted by construction of a private new 3-story, commercial office building over level subterranean parking garages planned adjacent to the eastern border of the study site (Figure 3). Grading began 21 June 2021 with parking garage excavation commencing 1 November 2021. Even though the County of Los Angeles requires on the title sheet of all grading plans "a preventive program to protect the slopes from potential damage from burrowing rodents per Section J101.8 of the County of Los Angeles Building Code" (Los Angeles County Building Code 2017), no rodent abatement was performed on the construction project prior to demolition.

Study Site #3

This study was conducted in the Queen Anne Business District of Seattle, WA in collaboration with R.A.T.S. (Seattle Chapter, WA) and Parker Eco Pest Control (Seattle, WA). The entire project is approximately 10 city blocks and is ongoing (Figure 4). The data reported here consists of the first phase, which is a planned mixed-use project, "21 Boston," in development. The project consists of 325 apartments situated on top of a new 50,000-square-foot grocery store and underground parking on a single city block. The project involved the demolition of a grocery store, parking lot, and other small structures. The Seattle building department requires a Rat Abatement Declaration for Demolition Projects (Seattle Department of Construction & Inspections 2019) for pre-demolition on city properties. For this project, the city allowed a one-time amendment to their abatement certificate procedure requiring poison with the substitution of fertility control product deployed by a licensed applicator.

Design of the bait distribution strategy involved a complete rodent site assessment by the authors and professional pest services provider and reviewed with the host facility management prior to bait station deployment. Bait stations (27, PROTECTA EVO Express®, Bell Laboratories Inc., Windsor, WI) were located and mapped throughout the facility and baited with two 400-ml tanks of liquid fertility control agent containing 0.096% 4-vinylcyclohexene diepoxide (VCD) and 0.001% triptolide. Indexing of the rodent populations on the site was developed to estimate differences in population abundance and not numerical abundance following the indexing principles reported by Engeman 2005. Rodent activity at the study site was quantitatively analyzed by rodent consumption of the liquid fertility control agent. Bait deployment was directed by licensed pest manager with engagement of community support. Bait deployment coincided with a community education event sponsored by the developer of "21 Boston" (barrientos RYAN, Seattle, WA) and facilitated by FYXX Foundation and R.A.T.S., Seattle.

Bait station inspections were performed every four weeks (July 2021 through March 2022). Consumption data was reported in ml and recorded for each bait station number during each inspection period by the licensed, on-site applicator.

RESULTS

The use of an integrated pest management program that does not include the use of poison is a key data set for the success of the SGARs bans in California, British Columbia, and pending in other states. Without an effective working set of tools, applicators are without critical resources. In all three studies conducted, no poison was used, and all three sites had a significant reduction of rodent population indexes.

Data for study site #1 indicated a rodent population reduction of 60% over the first four months and a 98% reduction over 27 months, with a sustainable threshold of 90% for the past 18 months (Table 1, and Figure 5). The initial number of bait stations deployed on site was 65 and reduced at month 10 (November 2020) to 20 stations with activity decreasing to two stations by month 27 (March 2021). In March 2021, a 3-month internal renovation project began on site. Camera trapping data was positively correlated with bait consumption by station (Spearman's Rank Order Correlation, $r = 0.7494$). Image analysis over four trapping sessions revealed a 27.5% proportion of juveniles (Table 2). Data from live trapping in month nine (September 2020) provided a snapshot of the population remaining after a 92% reduction in population. Five individuals were trapped: four rats (three females and one male) and one mouse (female). None of the females were pregnant, and the single male had no visible testes, but the shrunken testes were detected by palpation. Population age composition was 25% juveniles and 75% adults.

At the greatest rat population in study site #1, their intrusive presence even during daylight hours impacted staff's ability to do their jobs. Staff members made attempts to exclude rats from their areas. They tried various methods to control rat access to laundry, trash, and kennels, to protect vulnerable animals in nurseries and clinic areas, to mitigate damage to food stores and equipment, and to stop rats from making unexpected appearances in public adoption/foster areas.

Staff and volunteer welfare and positive mental health effects were assessed by individual interviews conducted by a trained, clinical psychologist and cultural anthropologist who used a standard questionnaire they developed. A total of 12 representative interviews were conducted between August and November 2020 in the four most infested areas of the facility based on rodent population index data. These areas included cat and dog intake and clinic, dog kennels and yards, cat nurseries, and public-facing office areas. There was pet food, treats, and water available in each of these areas. During the initial period of greatest rat presence, it seemed to almost all respondents that none of their attempts worked to reduce rat sightings and contacts. Volunteer and staff frustration was expressed as discontent with management efforts to resolve what had been a crisis. When management announced that The FYXX Foundation team had been invited to deploy liquid fertility control bait stations throughout the facility, staff still vacillated between skepticism and a cautious "wait and see" attitude. By this point, many staff found it difficult to believe in the possibility of solving the rat problem. Management's general message about pre-deployment period was that facilities such as theirs always had some rodent presence, and the rats' presence throughout the facility was tolerable and to be expected. Around March 2021, most staff members realized that the fertility control was working and with a sense of relief came to realize that "It works!".

Our work at study site #2 began in March 2021. The population reduction pattern was as expected based on previous data from study site #1 with a significant 80% population reduction in the first four months of treatment compared to a 60% reduction at the same time point at site#1 (Figure 6). The abrupt rise in population in November 2021 coincided with the start of construction of a two-story parking garage adjacent to the east side of the animal facility.

Table 1. Population and cost effects for each study site #1-3. Cost included product, travel time, and labor.

Site	Population Reduction	Product Reduction	Cost Reduction*	Length of Study
#1	98%	98%	89%	27 months
#2	80%	64%	28%	4 months
#3	91%	96%	76%	5 months

Population data for study site #3 indicated a population reduction of 91% in five months (Table 1). Initially 26 stations were deployed (June 2021). Stations were decreased to 23 in month three (November 2021) and activity was reduced to three stations (Figure 7). At deployment, a commercial lure (Rat & Mouse Attractant, LiphaTech, Milwaukee, WI) was used in each bait station. When signs of consumption of the lure were observed, a 400-ml tank of the fertility control product was inserted in place of the lure. Monitoring continued using the same lure-fertility control product each month.

DISCUSSION

Social/Public Opinion

The management of rodents has for centuries has been a challenge for humankind. Rodents are considered pests by virtue of their ability to carry disease, compete for food, and cause infrastructure damage. Society has historically viewed these animals as vermin that must be eliminated. When chemicals entered the solution "toolkit" to combat the overpopulation of rodents, they were embraced and rightfully so. With the evolution of technology and growing awareness of secondary and unintended effects of our chemical strategies, a dialogue has emerged to limit our use of harmful chemicals. Current themes in our discussions such as animal welfare concerns, contamination of our food web and environment, and safety have driven the need for science to become an innovative force in advancing new tools for pest management. The demands of the public will be met as policy makers address these issues.

In study site #1 the use of poison was not an option for the users. The rodent infestation was not being managed to the satisfaction of management and staff. The staff had made complaints to management and reports to agency officials. When the rodent population was reduced by 60% in the first four months, staff remarked in interviews that they did not see any rats at all. As management reports continued to show an average of 94% reduction for a sustained 18 months their positive testimonial to other facility managers increased. In animal welfare circles, the suspension of the use of poison has been very well received.

Political

The California Ecosystems Protection Act demonstrates the power of political activism that is driven by

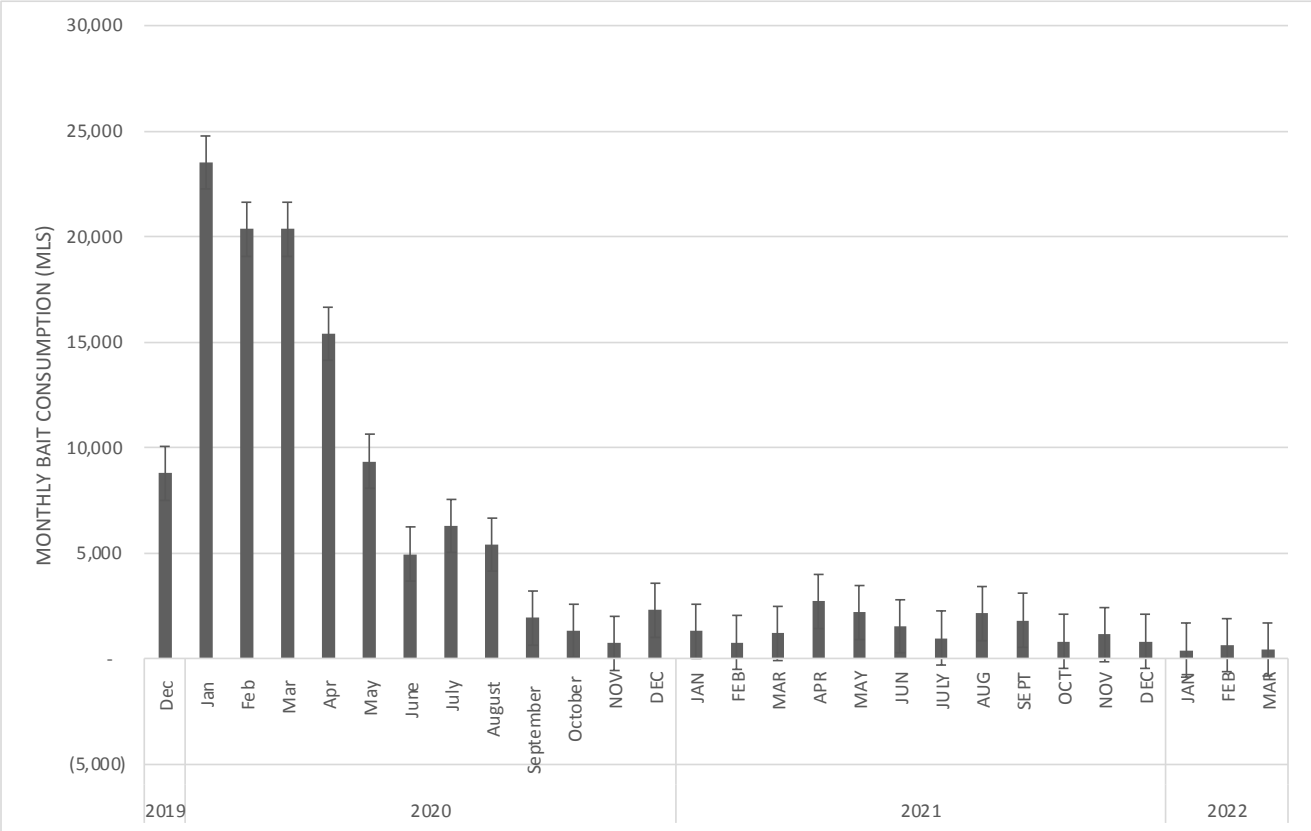

Figure 5. Study site #1. Monthly consumption (mls) of fertility control bait, ContraPest® from an enclosed animal rescue facility. Consumption measured monthly for 27 months showing e standard error of the mean.

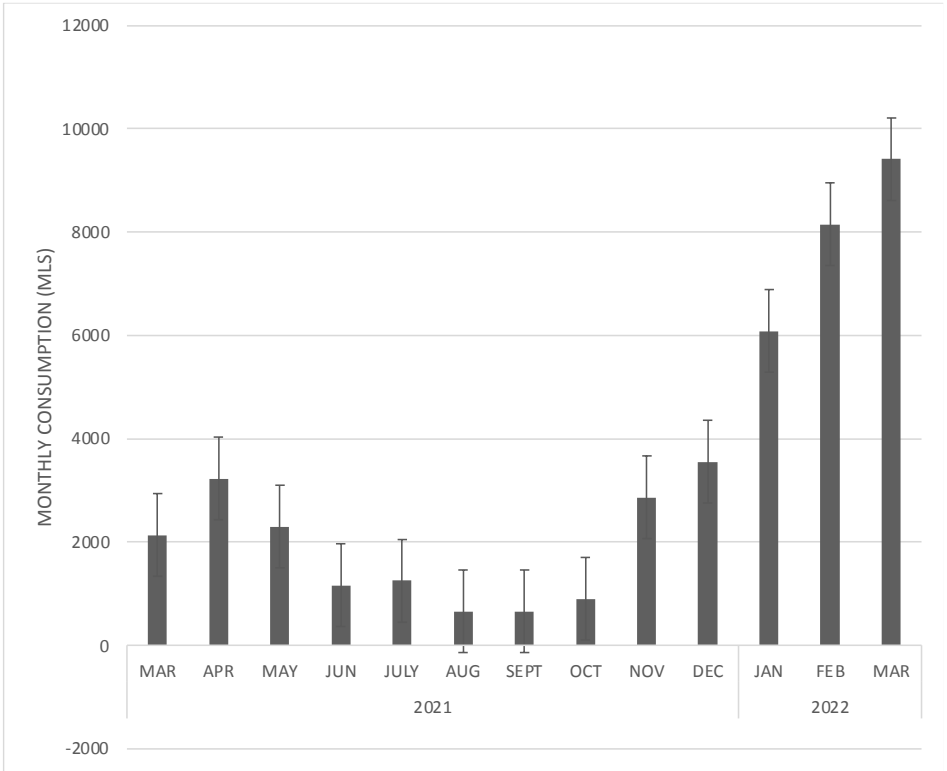

Figure 6. Study Site #2. Monthly consumption (mls) of fertility control bait, ContraPest® from an animal rescue facility. Consumption measured monthly for 12 months showing standard error of the mean

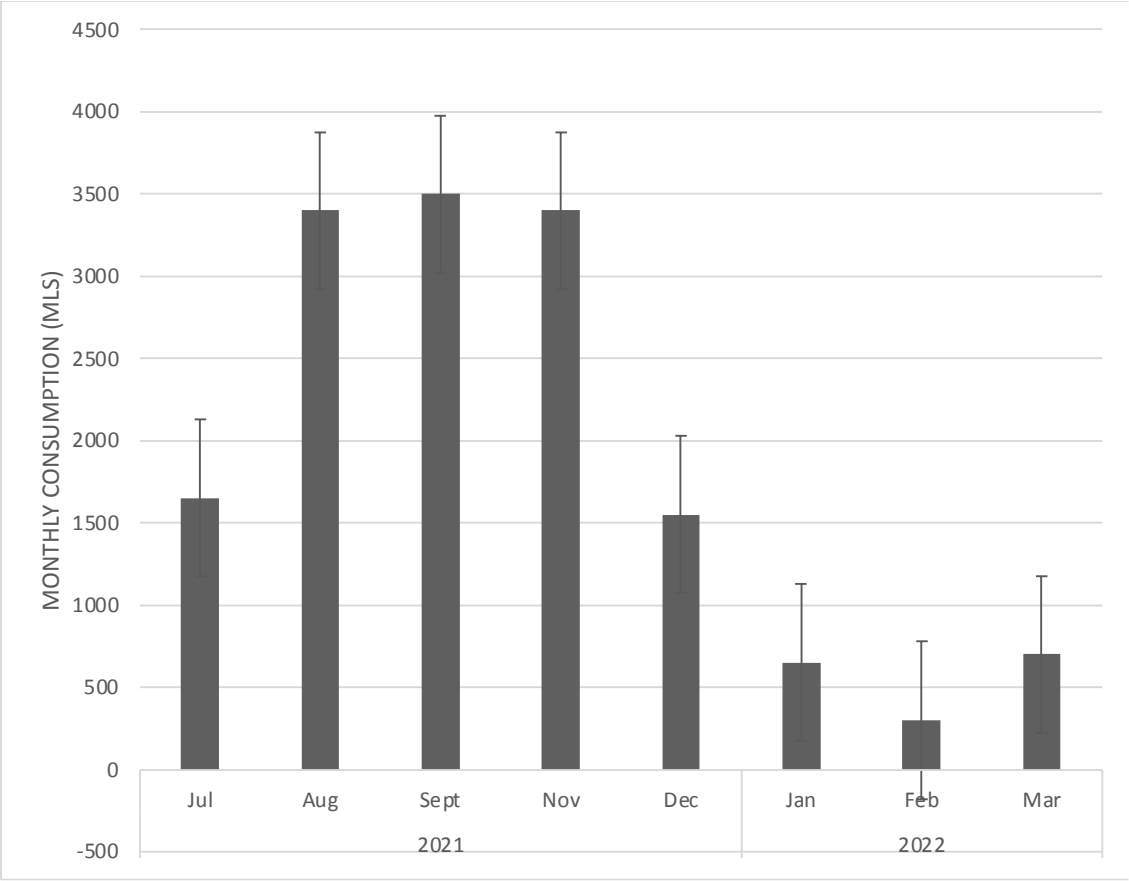

Figure 7. Study Site #3. Monthly consumption (mls) of fertility control bait, ContraPest® from an open urban construction site. Consumption measured monthly for 7 months showing standard error of the mean.

Table 2. Percentage of juvenile rodents over time collected by camera trapping and physical measurements at live trap collection timepoint.

Data Set	Date	% Juveniles	Total Captures	Adults	Juveniles
#1	27 Jul 2020	18%	39	32	7
#2	3 Aug 2020	31%	32	22	10
#3	10 Aug 2020	36%	42	27	15
#4	21 Sep 2020	25%	4	3	1

public awareness and using the innovation of science. The need for collaboration of all stakeholders in the management of rodent pests is critical for a successful outcome. In these studies, the engagement of scientific innovation, and public animal and wildlife stewards with commercial pest managers have provided a compelling data set to consider in bringing the pest management industry together with policy makers and the public.

Economic

Often as a society we have faced the cost of innovation as a barrier to embracing new technology: solar energy, vaccinations, electric automobiles, and many others. In our investigations we have yet again experienced this barrier. The first generation of rodent fertility control is expensive, requires empirical knowledge to deploy effectively, and is time consuming, all of which translates to a significant barrier to adoption. Again, a recurring theme is that collaboration of the stakeholders is critical to solving this problem.

The current understanding by the pest management industry appears to be lacking as it relates to their business models. There is no question the current first generation of fertility control product used in this study is more expensive than poison, as well as initial labor costs. But as fertility control effects on rat population take hold, the cost is reduced because fewer stations are needed to control fewer rats. The business model for applicators and expectations of users must provide for the "investment" characteristic of a fertility control strategy. It must be noted that the cost of rodents' resistance to poison is another hidden cost that can be eliminated with fertility control strategies,

as there is no natural selection for pools of resistant animals (Shuster et al. 2018). Consideration of the use of a fertility control strategy as presented here indicates the absence of population rebound. Continued monitoring shows a precipitous decline in labor and material, which has not been integrated into pest management business models. For example, in study site #1 the infestation required an initial deployment of 65 bait stations with weekly service initially. The first month's cost was $18,613 for product and service. The monthly cost for product and service in the last 18 months was $2,650. An investment business model based solely on averaging costs of a multi-month contract can indeed compel applicators to consider fertility control. For facility management, the reduced costs of employee retention, structural loss mitigation, animal feed, and janitorial and sanitation services are positive economic drivers in favor of fertility control.

These data taken together indicate that the evolution of rodent pest management strategies can move in concert with the social, political, and economic relationships currently intertwined because of the California Ecosystems Protection Act.

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